Potential role of Blue whiting exploitation patterns in the success of improving Hake selectivity in a Spanish Atlantic bottom otter-trawl mixed fishery

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Introduction

Match codend L_{50} to Minimum Landing Size (MLS) can be seen as a straightforward solution to reduce juveniles catches of a given species, but this strategy could lead to catch losses of other targets with lower MLS. Herein we address a Spanish case study related to this issue. Hake (*Merluccius merluccius* [L. 1758], hereafter HKE) is a valuable target species for the Bottom otter-trawl mixed fishery (hereafter OTB-mix) fishery operating in Galician waters ($VIII_c$-IX_a). Large quantities of individuals below MLS ($27cm$) are still caught and subsequently discarded in the fishery, suggesting that efforts should be made to improve selectivity on this species. However, the Introduction of HKE-based size selection improvements to commercial gears may conflict with fishing interest on other target species with lower MLS, such as Blue whiting (*Micromesistius poutassou* [Risso, 1826], hereafter WHB). This mismatch could be solved by introducing species selection devices, which split species within the trawl and drive the fractions to specific size selection panels. Nevertheless this approach success depends on an effective use (if exists) of differences in swimming-scape behaviour between species. Given this scenario, we propose a flow of questions intended to assess if WHB exploitation patterns in OTB-mix could play a key role in the success of potential HKE-based size selection improvements.

Questions

1. At what extent HKE-WHB selectivity parameters negatively interacts ?
2. Is it plausible the introduction of species selection devices for a jointly size selection optimization?
3. Given the WHB exploitation patterns in the OTB-mix, what would be the potential impact under a scenario of WHB losses?
4. Which future exploitation scenario would increase the likelihood of success of hake-based selectivity tools?

Exploratory Data Analysis

1. On HKE-WHB size selection

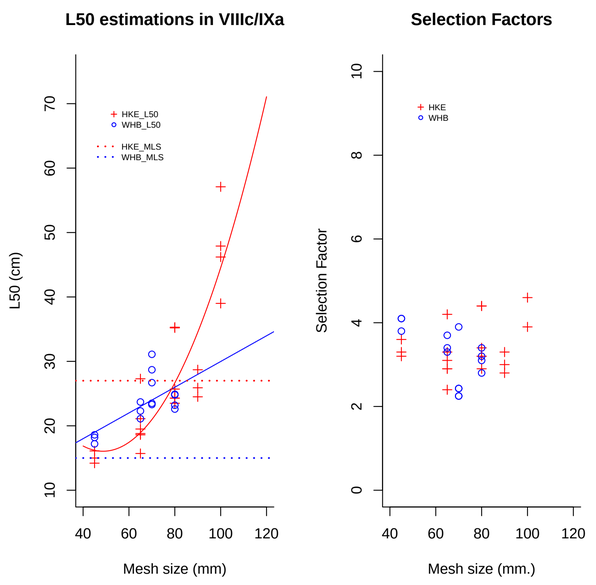

Figure 1: *Size selection parameters for WHB and HKE from Portuguese-Spanish surveys carried out during the last three decades (see references).* ***Left:*** *Size of 50% codend retention ($L_{50} = \frac{-a}{b}$). The fitted curve (solid red) shows an optimal codend mesh size (matching with MLS) at $\phi = 80mm$ for HKE. This mesh size is far above the MLS established for WHB, suggesting important WHB losses if $\phi = 80mm$ were introduced.* ***Right:*** *Selection Factors associated to observations.*

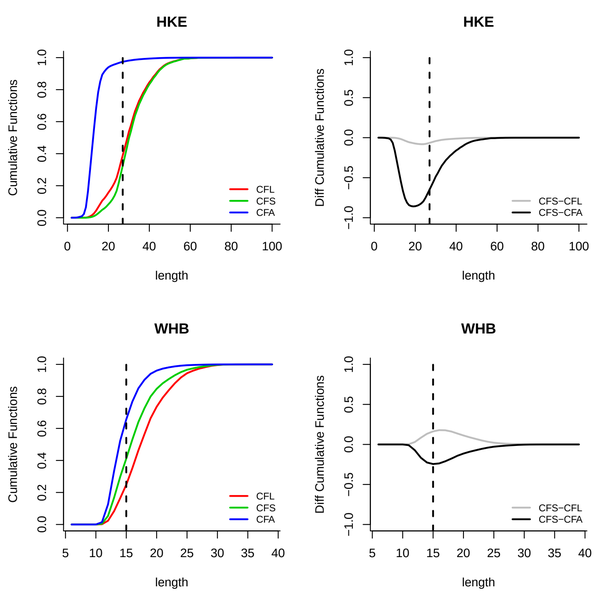

Figure 2: ***Left:*** *CFA=average species abundance (2003-2010 series) cumulative length distribution obtained by Spanish BTS 'Demersales'; CFL=Theoretical Cumulative landings length distribution once commercial ogive function (from onboard observers data, HKE 50% onboard retention length(RL^h_{50}) $= 26.28$, WHB $RL^w_{50} = 22.05$) is applied to CFA original data; CFS=Theoretical Cumulative length distribution of the retained fraction when applying selectivity parameters from $\phi = 80mm$ codend mesh size (HKE=$L^h_{50} = 26.1cm$, WHB=$L^w_{50} = 24.5cm$) to CFA original data.* ***Right:*** *Differences between CFS-CFL and CFS-CFA. This simulated scenario shows very low commercial HKE losses, while juveniles catches would be largely avoided. No losses of WHB is expected under the CFL produced by the mean OTB-mix onboard sorting ogive.*

2. On HKE-WHB species selection feasibility

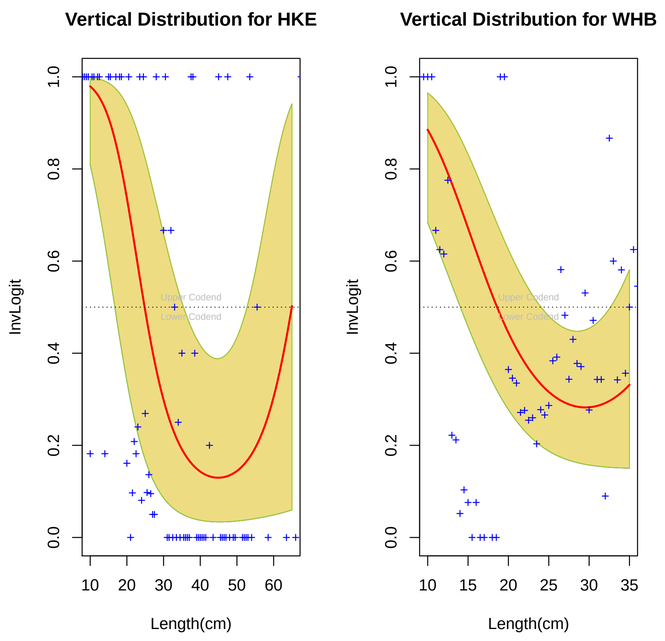

Figure 3: *Vertical distribution models for HKE and WHB in a gear vertically split by a horizontal panel from the belly. Double Codend were attached to the extension in order to get separate catches (information extracted from a set of hauls carried out during the ongoing Spanish project 'ASPAL'). No clear behavioural differences are found between species.*

3. On HKE-WHB exploitation patterns

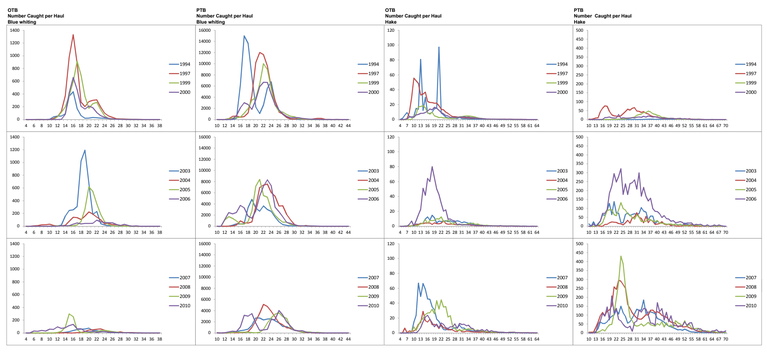

Figure 4: *Annual HKE-WHB catch per haul ($\frac{n}{haul}$) estimated for the OTB-mix and for the competing Pair trawl mètier directed to WHB (hereafter PTB-whb). In comparison, OTB-mix showed the strongest decrease in recent years WHB catches, while keeping stable levels of HKE catches.*

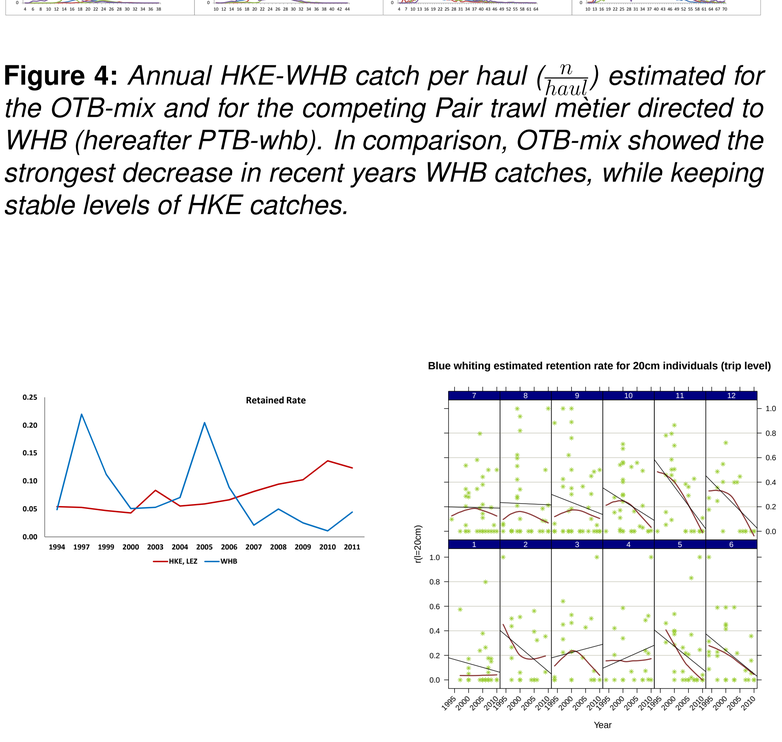

Figure 5: ***Left:*** *Yearly contribution of WHB (blue line) and other target species (HKE and Lepidorhombus spp. [LEZ]) to the global retained catch volume in OTB-mix.The panel shows an opposite trend between both landing fractions since the last 5 years.* ***Right:*** *Retention probability (by-trip GLM estimation for a commercial WHB length class (length=$20cm$)) by month and year.The fitted lines and curves show the retention rate for WHB to be in general low (all cases below 50%). It is noticeable a marked decrease of retention probability over the years.*

Figure 6: ***Left:*** *The empirical by-haul retention rate is negatively related to the onboard retained biomass since year 2000.* ***Right:*** *This trend is also found when plotting the estimated $r(l = 20)$ vs. other target species catches.*

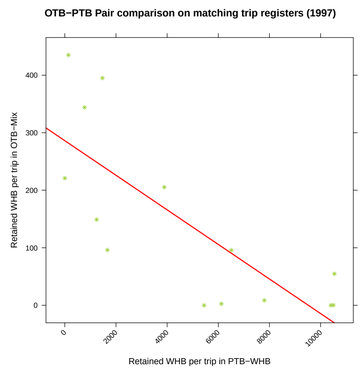

Figure 7: *Pair wise comparison between WHB retained biomass in OTB-mix and PTB-whb (for trips performed during the same month ended at the same port). Only 1997 sampling year contains enough matches for plotting. WHB by catches by OTB-mix are negatively related to those obtained by PTB-whb.*

Answers

1. HKE onboard sorting process is highly conditioned to legal restrictions ($RL^h_{50} \sim MLS^h$), in turn, the onboard WHB sorting is mainly conditioned by market preferences ($RL^w_{50} > MLS^w$). The match between discard ogives and selection curves found in Fig.2 indicates that future adoption of a $\phi = 80mm$ mesh size in the OTB-mix would not be negatively conditioned by a potential loss of WHB catchability.
2. Similar vertical distribution were found for both species (Fig.3). In the light of this preliminary results, it is not plausible the development of HKE-WHB species selection devices based on their vertical distribution in the trawl belly.
3. The OTB-mix interest for WHB has shown a decreasing trend in recent years, being the fishing strategy shifted to other targets, such as HKE or LEZ (Fig.4 to 6). As mentioned in Punzón *et al.* (2010), the preference for WHB in the OTB-mix may be conditioned by the more efficient PTB-whb catches (as showed in Fig.7). In the light of these results and those showed in Fig.2, we conclude that a HKE size selection approach (e.g. $\phi = 80mm$ adoption)) will not be negatively affected by the current WHB exploitation patterns.
4. We theorize that the more natural availability of target species such as HKE or LEZ, the less OTB-mix interest for targeting WHB. A step towards a selective and responsible fishing in the Spanish Atlantic coastal OTB mixed fisheries would lead to more availability of high valuable target species. Such scenario would maximize the success of the monospecific approach herein proposed.

References

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